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MINERALOGICAL NOTES No. 3.*

By

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(Plates xxvii-xxx.)

Calcite.

Garibaldi Mine, Lionsville, New South Wales.

(Plates xxvii, figs. 1-4, xxviii, xxix, fig. 1 and xxx.)

Some forty specimens of well crystallised calcite were collected by Mr. D. A. Porter in July, 1916, from the Garibaldi (Gold) Mine near Lionsville, about five miles west of the Upper Clarence River, Parish of Churchill, County of Drake, New South Wales. The mine is situated in very rugged country on the side of a spur about 730 feet above the Lionsville post office and about a quarter mile to the west.

According to Mr. Porter, the men were driving a tunnel and had driven about 150 to 200 feet when they noticed that one of the walls sounded quite hollow. They put in a charge of explosive and exposed a cavern with a cubic content of about 1200 cubic feet, but containing no calcite crystals of any note. The floor of the cavern was level with the floor of the tunnel and on the far side was a deep natural well about six feet in diameter, filled with clear water, the walls probably covered with calcite crystals. Beyond the well is a bar of rock rising up diagonally, and about two feet above the floor is a small opening leading into another chamber slightly larger than the first and completely lined with calcite crystals.

The largest single crystal collected by Mr. Porter measures approximately 33 cm. × 30 cm. × 28 cm., although very much larger crystals do occur, as I have seen one weighing several hundredweight. Some of the smaller crystals are quite transparent, but the majority become more or less cloudy toward the centre.

There appears to be no reference to the geology of the mine that will help to throw any light on the origin of the cave or the calcite. Mr. Porter reported that he was unable to find any limestone in or around the mine. Only two specimens in the collection contained matrix. In one the calcite is deposited on quartz containing minute dodecahedral and cubic crystals

*For No. 2, see " Records of the Australian Museum," vol. xv, no. 1, 1926, p. 69.

of pyrite disseminated fairly abundantly throughout. The matrix of the other specimen consists of a soft clayey material varying in colour from greenish-grey to almost black.

In view of the lack of any definite information on these points, I visited the mine in December, 1925, accompanied by my colleague Mr. C. M. G. Friend. Unfortunately most of the calcite crystals had been removed and many fine crystals broken up in the search for Iceland spar suitable for optical purposes. However these mining operations greatly facilitated the study of the structure of the cave. It was at once obvious that the cave had formed along an almost vertical fault plane cutting across the Garibaldi lode. The fault plane is indicated by a narrow fault breccia and the presence of much slickensiding. In the cave the rock on both sides of the fault plane appears to be identical. It is a very much altered felspar porphyry. Under the microscope the phenocrysts of felspar are seen to have been completely altered in many cases to saussurite and the ground mass consists of a fine grained complex of chlorite, calcite, and completely altered minute felspar laths.

An examination of the ore channel material of the Garibaldi Mine reveals the fact that it consists mainly of much decomposed country rock with quartz, calcite, and a little pyrite. The gold is not evenly distributed but is found in patches. The association of quartz and calcite is perhaps the most common to be found in veinstones, and in the numerous veins that occur in the district it is quite characteristic. A careful search was made for the presence of limestone in the vicinity of the cave, and for a radius of three-quarter mile at least, nothing but igneous rocks was found. The country is extremely rugged and covered with a semi-tropical vegetation rendering an examination somewhat difficult. The evidence of the boulders and pebbles found in the creeks draining the area failed to reveal the presence of limestone. In a private communication from Dr. W. F. Straubel, manager of this mine, received since my return, he informs me that marble has been reported about eight miles north east of Lionsville. It is extremely doubtful whether this marble bears any relation to the calcite under review.

The Garibaldi lode has not been displaced by the fault plane along which the cave has formed, so that it is evident that the fault plane is the older. It is very probable that the original cave was formed by a buckling of the rock along the fault plane at the time of its formation, and is therefore older than the lode. Although the cave is separated from the lode by country rock, the gold-bearing solutions must have penetrated the cave and there deposited both quartz and calcite. The fact that the country rock has been affected by these solutions for a considerable distance from the ore channel, and that a specimen of calcite with quartz and pyrite has been found in the cave, lends support to this view.

The roof of the cave has fallen and the original floor of the cave may be many feet below the present floor. It is certainly at least ten feet below. The falling in of the roof appears to have been subsequent to the formation of the lode, as I was unable to detect the presence of any quartz or silica in any form on the walls and roof of the cave. It would appear then that the crystals of calcite at present lining the cave have not been deposited from the gold-bearing solutions responsible for the formation of the Garibaldi lode.

In the absence of any limestone in the vicinity, the source of supply of calcium carbonate necessary for the formation of these huge crystals of calcite must be sought in the lode material and the impregnated country rock. Calcium carbonate is being deposited on the walls of the different levels of the Garibaldi Mine at the present time at a fairly rapid rate. It is obvious that these waters would be capable of depositing the calcite in the cave, provided that the inlet was greater than the outlet. In this connection it is significant that the cave was full or nearly full of water at the time when it was opened up by the miners. Under these conditions the circulation of the lime-bearing waters within the cave would be very slight and with a constant supply of calcium carbonate the conditions for crystal growth would be ideal.

The crystals occurring in the cave are divisible into two groups: (a) the Rhombohedral-scalenohedral Group and (b) the Prismatic Group. The former group includes all the large crystals and a fair number of the smaller ones, while the latter are invariably small. In general the prismatic crystals are of a later generation than the others; though occasionally they do belong to the same generation (Plate xxviii). Very often they are deposited on the larger crystals and separated from them by a thin layer of calcareous mud. In some specimens, after being kept in a dry place in the Museum for some time, the layer of mud dried and cracked, lifting the small prismatic crystals from off the larger ones.

The evidence of the mud indicates that there must have been a break in the ideal conditions under which the large crystals developed. This break must have been of relatively short duration during which much fine mud was brought into the cave water and deposited along with the calcium carbonate.

Eleven crystals were selected for measurement; nine of these were measured on a two-circle goniometer and the others on account of their size with an ordinary contact goniometer.

It will be seen from Table I that seventeen forms have been recognised. The lettering in this table is according to Goldschmidt and the indices correspond to his G_2 position. Two doubtful forms not shown in the table also occur; one, 𝔯: $(\bar{4}\,\bar{1}\,5\,2)$, is represented by two small faces in crystal ii, one giving an excellent signal and the other only a fair. The measured φ and p angles are 10° 10′ and 51° 52′, and the calculated angles are 10° 53′ and 52° 32′. The other form is represented by three narrow faces giving only fair signals and measurements of 2° 17′ and 76° 34′ for the φ and p angles. This does not correspond to any known form, the indices being $(8\ 164\ \overline{172}\ 23)$, and the calculated φ and p angles 2° 22′ and 76° 30′.

Table I: Distribution of forms.

Forms	i	ii	iii	iv	v	vi	vii	viii	ix	x	xi
o(0001)		×				×	×		×	×	
b(1 1 $\bar{2}$ 0)										×	×
γ(80$\bar{8}$1)	×			×	×						
$f\cdot$(1 1 $\bar{2}$ 2)							×				
$\delta\cdot$($\bar{1}$ $\bar{1}$ 2 2)							×				
$\eta\cdot$($\bar{4}$ $\bar{4}$ 8 5)	×	×	×								
$p\cdot$(1 1 $\bar{2}$ 1)	×	×	×	×	×	×	×	×	×		×
$\xi\cdot$($\bar{4}$ $\bar{4}$ 8 3)	×	×									
$\varphi\cdot$($\bar{2}$ $\bar{2}$ 4 1)	×	×	×	×	×	×	×	×			
$m\cdot$(44 $\bar{8}$ 1)	×	×	×	×	×	×		×			
$\Pi\cdot$($\bar{8}$ $\bar{8}$ 16 1)				×	×						
e:(2 1 $\bar{3}$ 2)	×	×	×								
G:(11 5 $\overline{16}$ 5)					×						
K:(4 1 $\bar{5}$ 1)	×	×	×	×	×	×	×	×	×		
O:(6 1 $\bar{7}$ 1)			×								
𝔯:($\bar{8}$ $\bar{4}$ 12 1)											×
U(6 2 $\bar{8}$ 1)	×										

The crystals measured form four distinct types.

Type 1. (Plate xxvii, fig. 1.) Crystals i-iii are of this type and they are all comparatively small. The characteristic forms are the positive rhombohedrons $p\cdot$(11$\bar{2}$1) and $m\cdot$(44$\bar{8}$1), the negative rhombohedrons $\eta\cdot$($\bar{4}\bar{4}$85) and $\varphi\cdot$($\bar{2}\bar{2}$41), and the scalenohedrons e:(21$\bar{3}$2) and K:(41$\bar{5}$1). In every case the last named form is represented by a full complement of fairly large faces giving excellent signals, and it was by this form that the crystals were centred. The faces of the forms $\eta\cdot$($\bar{4}\bar{4}$85) and e:(21$\bar{3}$2) were dull and sometimes irregularly pitted, in every case giving poor signals. All crystals of this type have a plane of attachment approximately parallel to a plane passing through the vertical axis and one of the horizontal axes.

Crystal i:—This crystal measures approximately 6 mm. × 4 mm. along the vertical and horizontal axes respectively. In addition to the characteristic forms of the type, the second order pyramid $\gamma\cdot$(80$\bar{8}$1), the negative rhombohedron $\xi\cdot$($\bar{4}\bar{4}$83), and the positive scalenohedron U(62$\bar{8}$1) are present. These are all represented by relatively small faces, and in general give only fair signals. The last form is interesting in that it is a comparatively rare form and is represented by its full complement of faces.

Crystal ii:—This crystal measures approximately 5 mm. × 4 mm. along the vertical and horizontal axes respectively. The basal pinacoid is very small and slightly pitted but gives a good signal. The doubtful form 𝔯:($\bar{4}$152) as described is above also present. With these additional forms and the absence of $\gamma\cdot$(80$\bar{8}$1) and U(62$\bar{8}$1) the crystal is similar to crystal i.

Crystal iii :—This crystal measures approximately 10 mm. × 8 mm., and has only one form, the positive scalenohedron O:$(61\bar{7}1)$, in addition to the type forms. It is represented by two very narrow faces giving rather poor signals.

Type 2. (Plate xxvii, fig. 2.) This type is represented by crystals iv-viii, and includes all the larger crystals as well as some of the smaller ones. The plane of attachment is roughly parallel to the plane of the horizontal axes. The positive rhombohedrons p·$(11\bar{2}1)$ and m·$(44\bar{8}1)$, the negative rhombohedron φ·$(\bar{2}\bar{2}41)$, and the positive scalenohedron K:$(41\bar{5}1)$ are the forms characteristic of this type, though the last form is always present as a relatively small face. The form p·$(11\bar{2}1)$ is generally striated parallel to the edges p·/m· and p·/K:. In the larger crystals m·$(44\bar{8}1)$ and K:$(41\bar{5}1)$ as narrow faces actually alternate with p·$(11\bar{2}1)$ for some distance toward the apex of the crystal.

Crystal iv :—This crystal measures approximately 20 mm. × 16 mm. and in addition to the type forms, Π·$(\bar{8}\,\bar{8}\,16\,1)$ and $\gamma(80\bar{8}1)$ are also present. Both the forms are represented by small, not very bright faces, giving only fair signals.

Crystal v :—This crystal measures approximately 18 mm. × 20 mm., and is similar to crystal iv except for the additional form G:$(11\,5\,\overline{16}\,5)$ which is represented by its full complement of faces which are generally dull. The striations on p·$(11\bar{2}1)$ are parallel to the edges p·/m· and p·/G:.

Crystal vi :—This crystal measures 18 mm. × 20 mm. The basal pinacoid, which is the only addition to the type forms, is present as a small narrow face giving a very good signal.

Crystal vii :—This crystal measures 22 cm. × 11 cm. and the interfacial angles measured with a contact goniometer are given in table III. The basal pinacoid is a relatively small triangular face. One of the type forms, m·$(44\bar{8}1)$ is not represented, but in addition to the other type forms the positive and negative rhombohedrons f·$(11\bar{2}2)$ and δ·$(\bar{1}\bar{1}22)$ are present, the former being represented by its full complement of faces, the latter by one face only.

Crystal viii :—This is only portion of a crystal having five cleavage faces present and measuring along the edges of the rhomb 23 cm. × 15 cm. × 5·4 cm. Only the type forms are present on this portion of the crystal. The measurements were taken with a contact goniometer.

Type 3. (Plate xxvii, fig. 3.) In crystals of this type the basal plane may or may not be present. The only other forms present are the positive rhombohedrons p·$(11\bar{2}1)$ and the positive scalenohedron K:$(41\bar{5}1)$. This type of crystal appears to be somewhat rare in the cave, as only three specimens containing clusters of crystals of this type were found. The crystals in every case were relatively small.

Crystal ix :—This crystal measures 10 mm. × 10 mm. along the vertical and horizontal axes respectively and was the only crystal of this type measured. Only type forms are present.

Table II. The measured and calculated φ and ρ angles.

Form	Measured				Calculated				Error	
	φ		ρ		φ		ρ		φ	ρ
	°	′	°	′	°	′	°	′	′	′
$o(0\ 0\ 0\ 1)$	...		0	0	...		0	0	...	0
$b(1\ 1\ \bar{2}\ 0)$	29	59	90	0	30	00	90	00	01	0
$\gamma(8\ 0\ \bar{8}\ 1)$	0	01	77	41	0	00	77	37	01	04
$\eta\cdot(\bar{4}\ \bar{4}\ 8\ 5)$	29	50	37	49	30	00	38	17	10	28
$p\cdot(1\ 1\ \bar{2}\ 1)$	30	00	44	39	30	00	44	36	0	03
$\xi\cdot(\bar{4}\ \bar{4}\ 8\ 3)$	29	57	52	50	30	00	52	45	03	05
$\varphi\cdot(\bar{2}\ \bar{2}\ 4\ 1)$	30	00	63	07	30	00	63	07	0	0
$m\cdot(4\ 4\ \bar{8}\ 1)$	29	58	75	43	30	00	75	47	02	04
$\Pi\cdot(\bar{8}\ \bar{8}\ 16\ 1)$	29	59	82	31	30	00	82	46	01	15
$e:(2\ 1\ \bar{3}\ 2)$	19	06	36	59	19	06	37	00	0	01
$G:(11\ 5\ \overline{16}\ 5)$	17	52	58	13	17	47	58	14	05	01
$K:(4\ 1\ \bar{5}\ 1)$	10	52	69	02	10	53	69	02	01	0
$O:(6\ 1\ \bar{7}\ 1)$	7	30	75	11	7	35	75	00	05	11
¥: $(\bar{8}\ \bar{4}\ 12\ 1)$	19	06	80	40	19	06	80	35	0	05
$U(6\ 2\ \bar{8}\ 1)$	13	28	76	48	13	54	76	19	26	29

Table III. The measured and calculated interfacial angles for calcite, Lionsville. The measurements were taken with a contact goniometer.

Letter	Angle	Measured		Calculated	
		°	′	°	′
$f\cdot$	$11\bar{2}2 \wedge \bar{2}111$	45	15	45	03
	$11\bar{2}2 \wedge 0001$	26	00	26	15
$p\cdot$	$11\bar{2}1 \wedge 0001$	44	15	44	36
$m\cdot$	$44\bar{8}1 \wedge \bar{8}441$	114	30	114	10
$\delta\cdot$	$\bar{1}\bar{1}22 \wedge 2\bar{1}\bar{1}2$	45	30	45	03
	$\bar{1}\bar{1}22 \wedge 0001$	26	30	26	15
$\varphi\cdot$	$\bar{2}\bar{2}41 \wedge 4\bar{2}\bar{2}1$	101	15	101	09
	$\bar{2}\bar{2}41 \wedge 0001$	63	15	63	07
$K:$	$41\bar{5}1 \wedge \bar{4}5\bar{1}1$	75	30	75	22
	$41\bar{5}1 \wedge 5\bar{1}\bar{4}1$	35	30	35	36

Type 4. Crystals of this type possess only the basal pinacoid and the first order hexagonal prism $b(11\bar{2}0)$. In order to determine which prism was present crystal x was cleaved.

Crystal xi (Pl. xxvii, fig. 4) is really a composite crystal and does not belong to any of the types so far described, and so far as the deposit is concerned is quite abnormal. It measures 4 mm. by 2 mm. along the vertical axis and its greatest width respectively. The form $p\cdot(11\bar{2}1)$ is represented by its full complement of faces and the negative scalenhedron $\mathfrak{F}$: $(\bar{8}\,\bar{4}\,12\,1)$ by only half its full complement. The basal pinacoid is striated parallel to the edge o/p. and in places its position is occupied by numerous small rhombohedral terminations. The $\dot{c}$ axis of the two parts of the composite crystal exactly coincide and the horizontal axes are parallel. The first order hexagonal prism $b(11\bar{2}0)$ is present in both parts.

Calcite.

Hanging Rock, Nundle, New South Wales.

(Pl. xxvii, fig. 5 and Pl. xxix, fig. 2.)

Five specimens of crystallised calcite from Hanging Rock, near Nundle, in the Parish of Nundle, County of Parry, New South Wales, are contained in the Museum collection. Only two forms have been recognised; the positive rhombohedron $f\cdot(11\bar{2}2)$ occurring as large faces giving good signals and the first order hexagonal prism $b(11\bar{2}0)$ as smaller faces generally much corroded and invariably giving bad signals. In some of the smaller crystals the prism faces are entirely absent. The largest crystal measures 3 cm. $\times$ 6 cm. along the vertical axis and the horizontal axes respectively. They are associated with crystallised quartz. On some of the crystals minute crystals of pyrite are deposited. They are so small that their form cannot be distinguished under the pocket lens but under the microscope they are seen to be perfectly formed octahedral crystals. It is interesting to note that they appear to be very much more numerous on and about the prism faces.

Table V. The average measured and calculated φ and ρ angles for calcite, Hanging Rock, Nundle.

Form	Measured		Calculated		Error	
	φ	ρ	φ	ρ	φ	ρ
	° ′	° ′	° ′	° ′	′	′
$b(11\bar{2}0)$	29 55	89 47	30 00	90 00	05	13
$f\cdot(11\bar{2}2)$	29 56	26 17	30 00	26 15	04	02

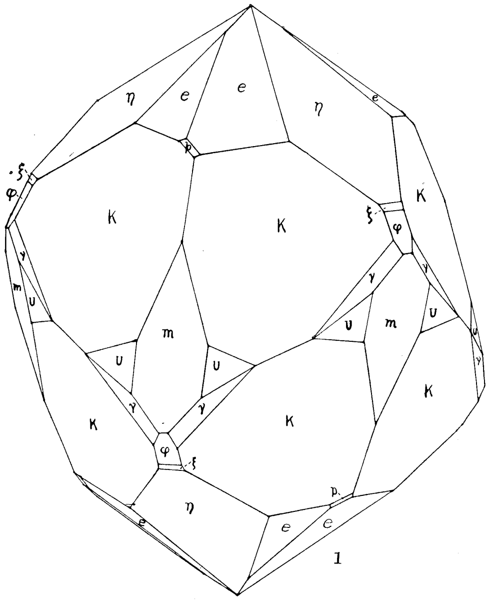
ACKNOWLEDGMENTS.

To Mr. Anthony Hordern, who generously defrayed expenses in connection with the field work, Dr. W. F. Straubel, Manager of the Garibaldi Mine, who afforded every facility, and my colleague, Mr. C. M. G. Friend, who assisted both in the field and in checking calculations, many thanks are due.

EXPLANATION OF PLATE XXVII.

Figs. 1-4. Calcite, Garibaldi Mine, Lionsville, New South Wales.
Forms : $o(0001)$, $b(11\bar{2}0)$, $\gamma(80\bar{8}1)$, $\eta\cdot(\bar{4}\bar{4}85)$, $p\cdot(11\bar{2}1)$, $\xi\cdot(\bar{4}\bar{4}83)$, $\varphi\cdot(\bar{2}\bar{2}41)$, $m\cdot(44\bar{8}\bar{1})$, $\Pi\cdot(\bar{8}\ \bar{8}\ 16\ 1)$, e:$(21\bar{3}2)$, K:$(41\bar{5}1)$, ¥ : $(\bar{8}\ \bar{4}\ 12\ 1)$, $U(62\bar{8}1)$.

Fig. 5. Calcite, Hanging Rock, Nundle, New South Wales.
Forms : $b(11\bar{2}\bar{0})$, $f\cdot(11\bar{2}2)$.



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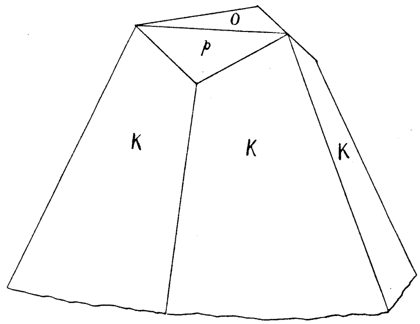

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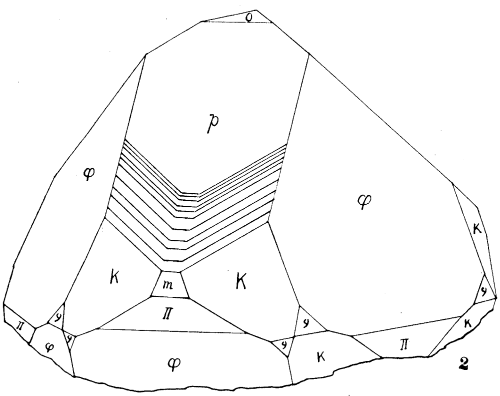

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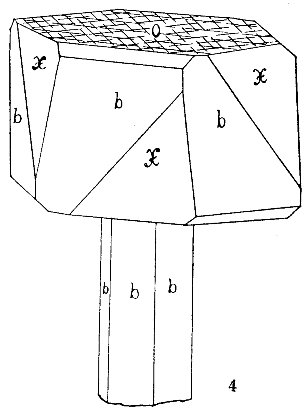

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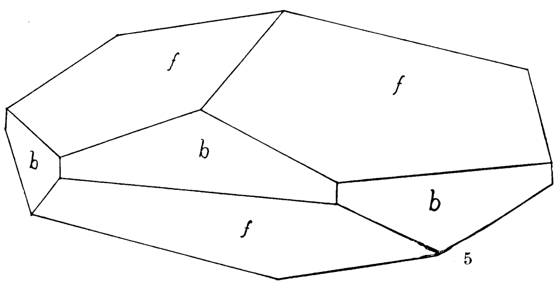
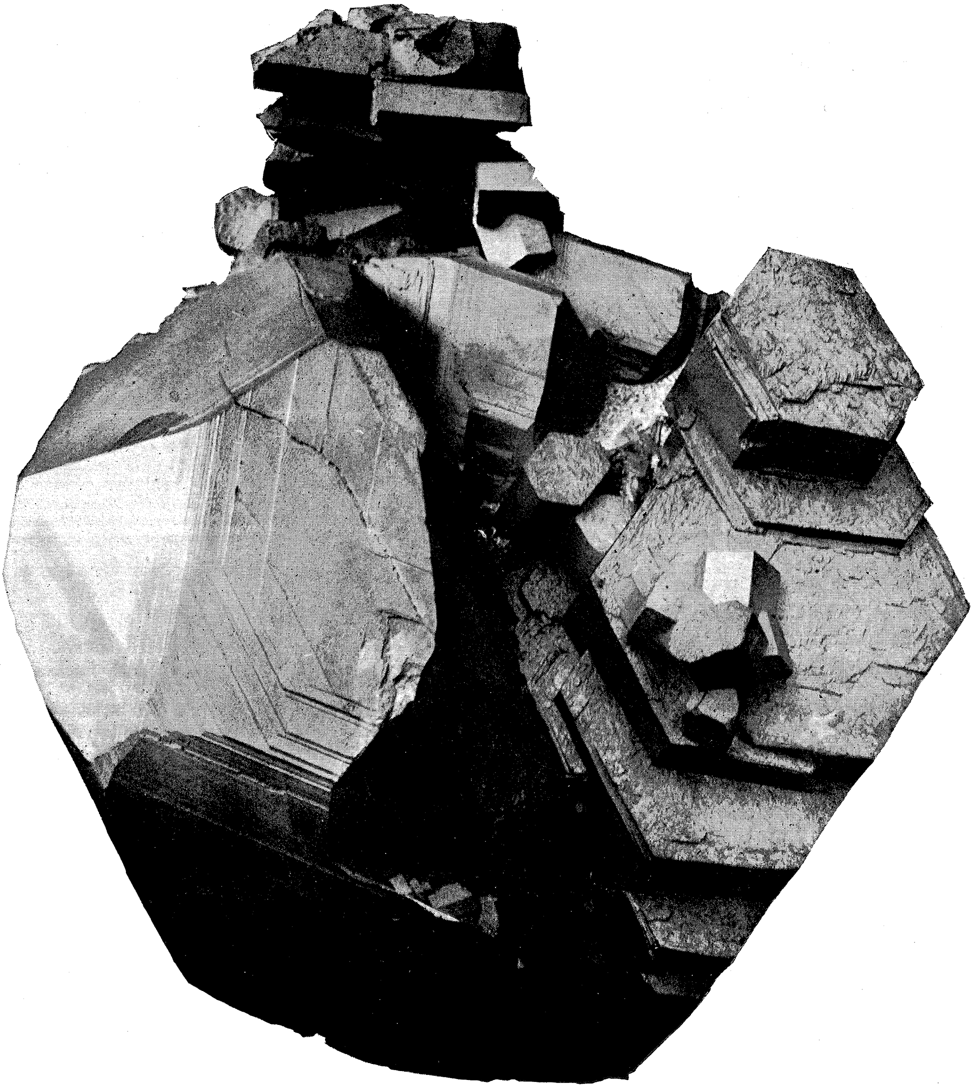


5

T. HODGE SMITH, del.

EXPLANATION OF PLATE XXVIII.

Calcite, Lionsville, New South Wales, showing crystals of the rhombohedral-scalenohedron (type II) and prismatic habit.



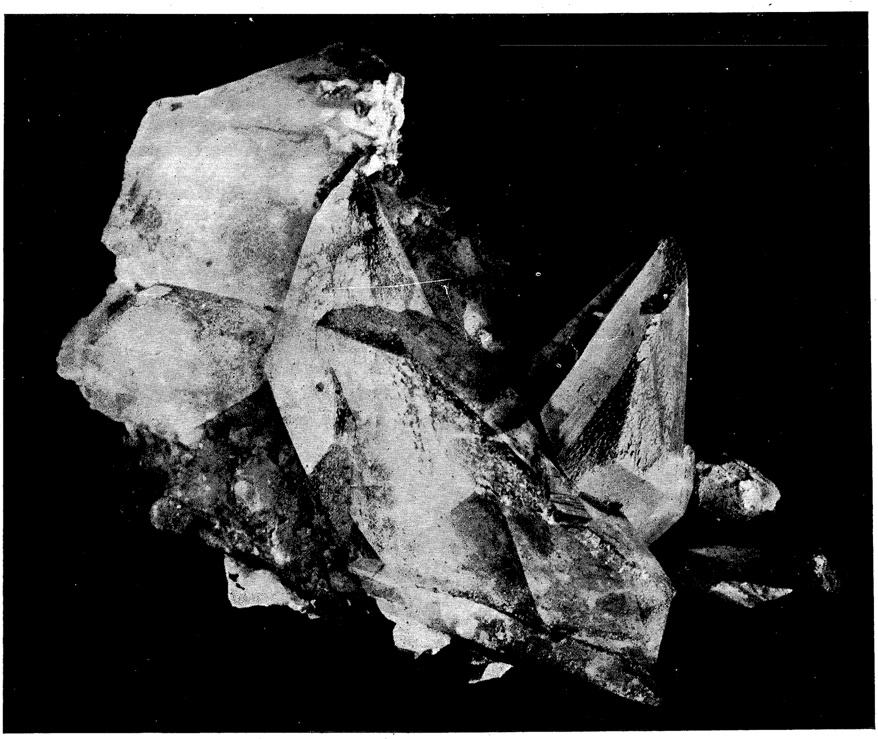
G. C. CLUTTON, photo.

EXPLANATION OF PLATE XXIX.

Fig. 1. Calcite, Garibaldi Mine, Lionsville, New South Wales. A typical group of the small rhombohedral-scalenohedral (type I) crystals.

" 2. Calcite, Hanging Rock, Nundle, New South Wales. Note the prism faces coated with minute crystals of pyrite.

1



2

G. C. CLUTTON, photo.

EXPLANATION OF PLATE XXX.

A view of the calcite dump at the entrance of the Garibaldi Mine, Lionsville, New South Wales. This material has been rejected as unsuitable for optical purposes and conveys some idea of the size of individual crystals.

C. M. G. FRIEND, photo.